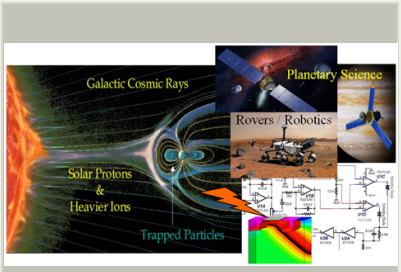
Radiation-Hardening of Best-In-Class SiGe Mixed-Signal and RF Electronics for Ultra-Wide Temperature Range, Phase I

Completed Technology Project (2014 - 2014)

Project Introduction

Innovative, reliable, low-power, and low-noise electronics that can operate over a wide temperature range and high radiation are critical for future NASA missions. This project will design, develop, and demonstrate novel Radiation Hardened By Design (RHBD) analog/mixed-signal and RF integrated circuits (ICs) implemented in the latest, best-in-class silicon germanium (SiGe) BiCMOS technology, for operation in extreme environments without bulky and power inefficient shielding and heating/cooling infrastructure. SiGe is a robust IC technology with superior electronic properties, design flexibility, and resilience to harsh environments. High yield and moderate cost of Si fabrication dramatically reduce mission size-weight-and-power and cost (SWaP-C). IBM's 90-nm state-of-the-art 9HP SiGe BiCMOS platform delivers higher performance and lower power, and enables highly integrated (sub-) millimeter wave applications not possible with earlier 180-nm or 130-nm nodes. It is therefore, a prime candidate for designing future mixed-signal/RF electronics for NASA. Currently, however, there are few wide-temperature/radiation data and models, and no radiation/wide-temperature tolerant circuits in this platform. Advanced Computer Aided Design (CAD) tools are also essential for in-depth analysis to optimize design, predict behavior, and assess performance of 9HP-based electronics. CFDRC and Georgia Tech will perform laser-based and heavy ion irradiation testing on the newest generation 9HP SiGe HBT devices and circuits, and develop new models and upgraded CAD tools. The wide-temperature/radiation experimental data will help validate the models and understand associated failure mechanisms. This new knowledge, data, and upgraded CAD tools will be used in Phase II for development and optimization of novel RHBD mixed-signal/RF circuits and systems, which will be fabricated in the IBM 9HP SiGe process, extensively tested at low temperatures and radiation, and delivered to NASA.



Radiation-Hardening of Best-in-Class SiGe Mixed-Signal and RF Electronics for Ultra-Wide Temperature Range Project Image

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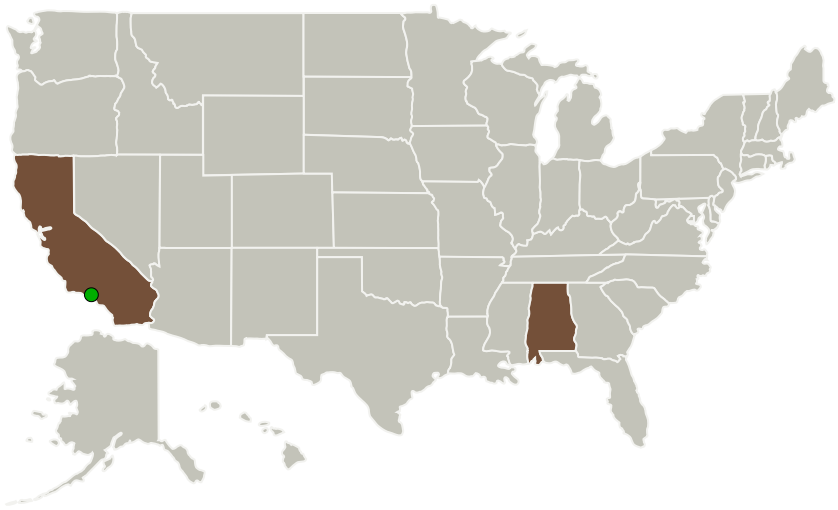
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
CFD Research Corporation	Lead Organization	Industry	Huntsville, Alabama
Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations	
Alabama	California

Project Transitions

June 2014: Project Start

December 2014: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/140604)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

CFD Research Corporation

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

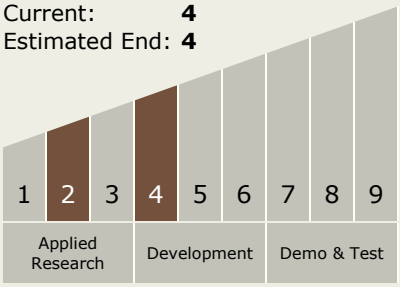
Carlos Torrez

Principal Investigator:

Ashok Raman

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**



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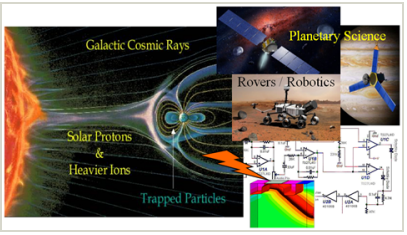
Images



Project Image
Radiation-Hardening of Best-in-Class SiGe Mixed-Signal and RF Electronics for Ultra-Wide Temperature Range Project Image *(https://techport.nasa.gov/image/133689)*

Technology Areas

Primary:

- TX05 Communications, Navigation, and Orbital Debris Tracking and Characterization Systems
  - TX05.2 Radio Frequency
    - TX05.2.2 Power-Efficiency

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System